

[0056] What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A method of forming a composite insulating structure, comprising:

forming at least one gate stack structure over a substrate;

forming a source/drain region in said substrate on opposite sides of said gate stack structure;

forming an oxide layer over at least said source/drain region, said oxide layer being formed by oxidizing an upper surface of said source/drain region using atomic oxygen; and

forming a barrier layer over said oxide layer.
2. The method of claim 1 further comprising the step of forming a glass layer in contact with said barrier layer of said composite insulating structure.
3. The method of claim 2, wherein said glass layer is a doped glass film.
4. The method of claim 3, wherein said doped glass film includes BPSG material.
5. The method of claim 3, wherein said doped glass film includes PSG material.

6. The method of claim 1, wherein said oxide layer is grown at a temperature of about 850 °C to 1100 °C.
7. The method of claim 1, wherein said oxide layer is grown at a temperature less than about 900 °C.
8. The method of claim 1, wherein said oxide layer is grown for about 1 second to about 10 minutes
9. The method of claim 1, wherein said atomic oxygen is supplied by in situ steam generation.
10. The method of claim 1, wherein said atomic oxygen is supplied by an ozone source.
11. The method of claim 1, wherein said atomic oxygen is supplied by a plasma source.
12. The method of claim 1, wherein said atomic oxygen is supplied by a microwave source.
13. The method of claim 1, wherein said atomic oxygen is supplied by photoexcitation.

14. The method of claim 1, wherein said oxide layer is formed in a batch furnace system.

15. The method of claim 1, wherein said oxide layer is formed to a thickness of about 20 Angstroms to about 500 Angstroms.

16. The method of claim 1, wherein said oxide layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

17. The method of claim 1, wherein said barrier layer is formed of an insulating material selected from the group consisting of silicon nitride, silicon oxide, silicon dioxide, silicon carbide and high temperature polymers.

18. The method of claim 1, wherein said barrier layer is formed to a thickness of about 30 Angstroms to about 150 Angstroms.

19. The method of claim 1, wherein said barrier layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

20. The method of claim 1, wherein said oxide layer and said barrier layer are further formed over said gate stack, said gate stack including a plurality of spacers formed on sidewalls of said gate stack structure.

21. A method of forming a memory cell, comprising:

forming a plurality of gate stacks over a substrate, each of said plurality of gate stacks comprising a gate oxide layer and a conductive layer;

forming spacers on sidewalls of each of said plurality of gate stacks;

forming source/drain regions in said substrate on opposite sides of each of said plurality of gate stacks;

forming a composite barrier layer over said source/drain regions, said composite barrier layer comprising an oxide layer formed by oxidizing upper surfaces of said source/drain regions using atomic oxygen, and a barrier layer formed over said oxide layer;

forming a glass insulating layer over said composite barrier layer;

forming an opening in said glass insulating layer and said composite barrier layer to expose at least a portion of said upper surfaces of said source/drain regions; and

forming a conductor in said opening.

22. The method of claim 21, wherein said oxide layer of said composite barrier layer is grown at a temperature of about 850 °C to 1100 °C.

23. The method of claim 21, wherein said oxide layer of said composite barrier layer is grown at a temperature less than about 900 °C.

24. The method of claim 21, wherein said oxide layer of said composite barrier layer is grown for about 1 second to about 10 minutes.
25. The method of claim 21, wherein said atomic oxygen is supplied by in situ steam generation.
26. The method of claim 21, wherein said atomic oxygen is supplied by an ozone source.
27. The method of claim 21, wherein said atomic oxygen is supplied by a plasma source.
28. The method of claim 21, wherein said atomic oxygen is supplied by a microwave source.
29. The method of claim 21, wherein said atomic oxygen is supplied by photoexcitation.
30. The method of claim 21, wherein said oxide layer of said composite barrier layer is formed in a batch furnace system.
31. The method of claim 21, wherein said oxide layer of said composite barrier layer is formed to a thickness of about 20 Angstroms to about 500 Angstroms.

32. The method of claim 21, wherein said oxide layer of said composite barrier layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

33. The method of claim 21, wherein said barrier layer of said composite barrier layer is formed of an insulating material selected from the group consisting of silicon nitride, silicon oxide, silicon dioxide, silicon carbide and high temperature polymers.

34. The method of claim 21, wherein said barrier layer of said composite barrier layer is formed to a thickness of about 30 Angstroms to about 150 Angstroms.

35. The method of claim 21, wherein said barrier layer of said composite barrier layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

36. The method of claim 21, wherein said composite barrier layer is further formed over said plurality of gate stacks including said spacers formed on sidewalls of each of said plurality of gate stacks.

37. The method of claim 21, wherein said glass insulating layer is a doped glass film.

38. The method of claim 37, wherein said doped glass film includes BPSG material.

39. The method of claim 37, wherein said doped glass film includes PSG material.

40. A method of preventing the diffusion of atoms from a glass insulating layer into a source/drain region formed between adjacent gate stacks of a memory device, comprising:

forming spacers on sidewalls of said gate stack; and

forming a composite barrier layer over said source/drain region and said adjacent gate stacks including said spacers, said composite barrier layer comprising an oxide layer formed by oxidizing an upper surface of said source/drain region using atomic oxygen, and a barrier layer formed over said oxide layer.

41. The method of claim 40, wherein said oxide layer of said composite barrier layer is grown at a temperature of about 850 °C to 1100 °C.

42. The method of claim 40, wherein said oxide layer of said composite barrier layer is grown at a temperature less than about 900 °C.

43. The method of claim 40, wherein said oxide layer of said composite barrier layer is grown for about 1 second to about 10 minutes

44. The method of claim 40, wherein said atomic oxygen is supplied by in situ steam generation.

45. The method of claim 40, wherein said atomic oxygen is supplied by an ozone source.

46. The method of claim 40, wherein said atomic oxygen is supplied by a plasma source.

47. The method of claim 40, wherein said atomic oxygen is supplied by a microwave source.

48. The method of claim 40, wherein said atomic oxygen is supplied by photoexcitation.

49. The method of claim 40, wherein said oxide layer of said composite barrier layer is formed to a thickness of about 20 Angstroms to about 500 Angstroms.

50. The method of claim 40, wherein said oxide layer of said composite barrier layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

51. The method of claim 40, wherein said barrier layer of said composite barrier layer is formed of an insulating material selected from the group consisting of silicon nitride, silicon oxide, silicon dioxide, silicon carbide and high temperature polymers.

52. The method of claim 40, wherein said barrier layer of said composite barrier layer is formed to a thickness of about 30 Angstroms to about 150 Angstroms.

53. The method of claim 40, wherein said barrier layer of said composite barrier layer is formed to a thickness of about 50 Angstroms to about 100 Angstroms.

54. The method of claim 40, wherein said glass insulating layer is a doped glass film.

55. The method of claim 54, wherein said doped glass film includes BPSG material.

56. The method of claim 54, wherein said doped glass film includes PSG material.

57. A memory cell comprising:

a plurality of gate stacks over a substrate, each of said plurality of gate stacks comprising a gate oxide layer and a conductive layer, and spacers on sidewalls of each of said plurality of gate stacks;

source/drain regions in said substrate on opposite sides of each of said plurality of gate stacks;

a composite barrier layer over said source/drain regions, said composite barrier layer including an oxide layer having a composition formed by the oxidation of upper surfaces of said source/drain regions using atomic oxygen; and

a glass insulating layer over said composite barrier layer.

58. The memory cell of claim 57, wherein said composite barrier layer further includes a nitride barrier layer formed over said oxide layer.

59. The memory cell of claim 57, wherein said oxide layer has a thickness of about 20 Angstroms to about 500 Angstroms.

60. The memory cell of claim 57, wherein said oxide layer has a thickness of about 50 Angstroms to about 100 Angstroms.

61. The memory cell of claim 57, wherein said glass insulating layer includes BPSG material.

62. The memory cell of claim 57, wherein said glass insulating layer includes PSG material.

63. A processor-based system comprising:

a central processing unit;

a memory device coupled to said processing unit to receive data from and supply data to said central processing unit, said memory device having a memory cell comprising:

a plurality of gate stacks, each of said plurality of gate stacks comprising a gate oxide layer and a conductive layer, and spacers on sidewalls of each of said plurality of gate stacks;

source/drain regions on opposite sides of each of said plurality of gate stacks;

a composite barrier layer over said source/drain regions, said composite barrier layer including an oxide layer having a composition formed by the oxidation of upper surfaces of said source/drain regions using atomic oxygen; and

a glass insulating layer over said composite barrier layer.

64. The processor-based system of claim 63, wherein said composite barrier layer further includes a nitride barrier layer formed over said oxide layer.

65. The processor-based system of claim 63, wherein said oxide layer has a thickness of about 20 Angstroms to about 500 Angstroms.

66. The processor-based system of claim 63, wherein said oxide layer has a thickness of about 50 Angstroms to about 100 Angstroms.

67. The processor-based system of claim 63, wherein said glass insulating layer includes BPSG material.

68. The processor-based system of claim 63, wherein said glass insulating layer includes PSG material.

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